



Newsletter

Volume 5, Number 5
September - October 1988

Director's Note

September 3rd marked the Institute's 5th Anniversary. This is therefore an appropriate time for a quick update:

- The permanent scientific staff at IES consists of 14 with Ph.D.s and 3 with masters degrees.
- The IES Public Education Program has seven on its staff.
- The total number of employees at the Institute, including these scientists and educators as well as support staff, graduate students, research assistants and horticulturists, is currently 100. This number rose to approximately 140 during the summer, when high school and college students were hired to work with regular staff.
- 64 volunteers are currently assisting in all aspects of the Institute's operation.
- 51 research papers about IES studies were published in scientific journals from July 1987 through June 1988. From July 1988 to date, 36 papers were published, with an additional 51 now in press.
- New attractions for visitors include the Cary Pines Trail loop, a photographic display in the greenhouse and seasonal research demonstrations.

The IES Newsletter is published by the Institute of Ecosystem Studies at the Mary Flagler Cary Arboretum. Located in Millbrook, New York, the Institute is a division of The New York Botanical Garden. All newsletter correspondence should be addressed to the Editor.

Gene E. Likens, Director
Joseph S. Warner, Administrator
Alan R. Berkowitz,
Head of Education

Editor: Jill Cadwallader
Design and Printing: Central Press

INSTITUTE OF
ECOSYSTEM STUDIES
The New York Botanical Garden
Mary Flagler Cary Arboretum
Box AB
Millbrook, NY 12545
(914) 677-5343

Eco-Inquiry: Building Bridges Between School Science and Professional Science

...I never thought scientists were like real people. I thought of them (as) I saw them on t.v. and books.

...I (liked best) learning how to think and act like a scientist when they find a problem or something puzzling.

...I (liked best) experiments because I'm learning something....by finding it out on my own.

These comments are representative of those made by the 700 fifth and sixth grade students who have participated in an innovative school science program called "Eco-Inquiry." In 1986, Eco-Inquiry's creator, Institute of Ecosystem Studies (IES) Program Leader in Ecology Education, Kass Hogan, began piloting the program in elementary schools in Dutchess County, New York to develop and refine the curriculum. Then, in a mid-September 1988 workshop, she introduced teachers from 10 Dutchess County schools to the prototype: a thirty session program in which teachers help students understand processes in nature while exploring their own capacities for finding original answers to ecology research questions.

Eco-Inquiry has three themes. First, ecosystem concepts are introduced as the students explore how living and non-living

parts of an ecosystem interact. Second, activities that are modeled after practices of the scientific community lead to an understanding of who scientists are, what they do and why they do it. Finally, the program teaches scientific inquiry skills: students learn investigative techniques through simple experiments, then are challenged to design their own experiments. The Eco-Inquiry sessions emphasize not only the skills of disciplined thinking but also the attitudes that support inquiry behavior. The curriculum works to develop intellectual curiosity, open-mindedness, persistence, objectivity, ability to learn from failure, and commitment to accuracy -- attributes with long-term benefits in both academics and everyday life.

For the 4-day teacher workshop, Ms. Hogan prepared kits with all the 'props' required to teach the 30 sessions. A curriculum guide, background readings in ecology, and "Rita", a book written by Ms. Hogan especially to complement the Eco-Inquiry curriculum, were also in the kits.

Participating teachers will introduce the curriculum to their classes during the 1988/89 school year, and are being

continued on page 4



During the first part of the Eco-Inquiry workshop, IES scientists led the teachers in field programs and in discussions about the scientific method. On Friday afternoon, Dr. Mark McDonnell (wearing a cap) and the group dealt with the subject of forest ecology in a perfect classroom setting.

Tracking Opossums from Birth

The oldest mammal in North America, and our only marsupial (a mammal whose young grow within an abdominal pouch) the Virginia opossum, *Didelphis virginiana*, is slowly working its way north. This primitive animal appeared in the Hudson Valley in the early 1930s; the first in this area was found in Peekskill after being hit by a car.

Opossums have now reached the lower Adirondacks, surviving in the Northeast in spite of the fact that their bodies, with naked ears and tail, are not adapted for long spells of freezing temperatures. The expanding range of opossums may be due in part to the expanding range of humans: in addition to their natural diet that includes amphibians, insects and vegetation, these animals will quite happily eat garbage or even boldly take food from a pet's bowl left outside overnight. While the animals' life span in southern states is 7 to 10 years, in northern climates it is much shorter. Females, who face the winter in poor physical condition with lowered fat reserves after breeding and raising young, live an average of one and a half years; males, whose lives are considerably easier, live three years or so.

The scientific literature has offered few answers to questions about how opossums survive in these northern climates, and particularly about how young opossums progress from birth to adulthood. Robert J. Hossler has just completed two seasons of field work at the Institute of Ecosystem Studies, making observations and gathering the kinds of information needed to answer some of these questions.

In May 1985 Mr. Hossler was hired as a research assistant with the Institute's Lyme Disease study. In the course of that work, which involved sampling the Arboretum's mammals for the presence of the Lyme tick, he discovered that there was an established opossum population on the property. At the same time, Dr. John D. Harder, a reproductive physiologist at Ohio State University, was looking for a graduate student to do research on opossums. Mr. Hossler learned of Dr. Harder through one of Harder's former master's degree students, IES wildlife ecologist Jay McAninch. He applied, was accepted, and began his master's degree studies in January 1987.

Mr. Hossler returned to IES during the spring and summer of 1987 and 1988 to do his field work on the Arboretum and adjoining properties*. Animals were caught in live traps or by hand, weighed, and -- in the case of captured females -- information on the young in the pouch was recorded. Before release at the site of capture, the adults were fitted with radio collars weighing only 28 grams (just under one ounce) that could transmit signals up to 0.8 kilometers (0.5 miles). The animals

were then tracked in order to learn what areas they used for foraging and resting.

In southeastern New York, female opossums give birth during the early-March to late-April period, depending on the severity of the winter. At birth the baby opossums are little more than embryos -- 13 can fit on a teaspoon. As many as 22 young may be born at one time, but no more than 13 or 14 survive... one for each nipple inside the mother's pouch. (The average number of young, however, is eight.) Each newborn opossum attaches itself to a nipple so firmly that it cannot be dislodged, and it feeds there for 50 days. After this time, its eyes open and it can move around with its siblings inside the pouch. The young are weaned from 98 to 106 days after birth; during this time they move from the pouch onto the mother's back, traveling with her or exploring for short distances on their own. Mr. Hossler observed his tagged female animals during three stages: while the young were in the pouch, during the weaning process, and after she had left the juveniles to take care of themselves.

He found that opossums take over burrows abandoned by other animals, such as woodchucks, and may use as many as six dens during the stages before and after weaning. They prefer to live in an edge

habitat, such as along roadsides.

During the weaning period, however, the mother opossum tends to use just one den, located in dense vegetation. When she forages at night, she leaves the young, who start to explore for food on their own. The dense cover around the weaning den helps to protect the young from predators such as owls, coyotes, foxes and domestic dogs. By October the juveniles have been on their own for approximately 90 days, and start moving greater distances to extend their feeding ranges and increase fat reserves for the coming winter.

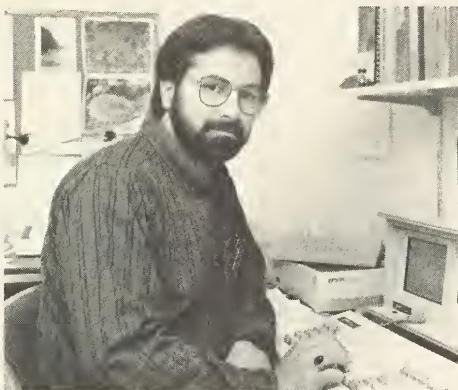
Rob Hossler is now back at Ohio State, analyzing the two years of data on habitat preference and weaning behavior of the opossum. One of his more interesting findings deals with the latter. While most young animals must be driven from the nest or den when the weaning process is completed, in the case of the opossum the mother is the one who leaves. A new body of knowledge on the ecology of a local mammal has been created from this recent study, and Mr. Hossler will publish the results of his master's thesis work in scientific journals.

**Rob Hossler thanks the residents of Woodstock Road and properties adjoining the Arboretum for allowing him access throughout the course of his field work.*



New Postdoctoral Research at IES

The Institute makes postdoctoral appointments to enable outstanding young ecologists to contribute to the Institute's program and to establish themselves in the scientific community. Two postdoctoral associates have recently begun training and research at IES:



GLYN CLOYD

THOMAS S. BIANCHI, aquatic ecologist, received his Ph.D. in marine ecology from the Chesapeake Biological Lab., University of Maryland. His research there dealt with the feeding ecology of benthic (bottom living) invertebrates -- specifically snails and polychaete worms -- in Delaware Bay and Long Island Sound.

Working at IES with Dr. Stuart Findlay, he will study the cycling of organic matter in Hudson River sediments. Most of the organic matter settling to the river bottom comes from leaves from the river banks, or from river plants and plankton (suspended microscopic forms). In this project, funded by a grant from the Hudson River Foundation, the scientists will try to understand what the principal food resources are for the Hudson's food chain and how these resources vary seasonally. The results will have implications to the river's fish population.

Dr. Bianchi is also collaborating with IES aquatic ecologist Dr. David Strayer on a study of the evolutionary genetics of snails across New York. The genus of the snail in question is *Goniobasis*. Originally, one species, *G. livescens*, was found in the western part of the state, in the Mohawk River drainage basin, and a second species, *G. virginica*, lived east, in the Hudson River drainage basin. With the opening of the Erie Canal in 1825, the two species were able to extend their ranges and are now coexisting along part of the canal. Drs. Bianchi and Strayer will use this natural phenomenon to learn how related organisms interact when they come into contact with each other, and will study the animals' shells to see if hybridization has occurred.

LARS O. HEDIN, an aquatic ecologist who will soon receive his doctorate degree from Yale University, did his thesis research on changes in the chemistry of rainfall. Working at IES with his thesis

advisor, Dr. Likens, and with a research group at the University of Stockholm in Sweden, he analyzed data from long-term studies of rainfall chemistry (extending back 25-30 years) trying to understand the factors that affect the acidity of rainfall both in the northeastern part of the U.S. and in Europe. He found that while there is variability in pollutant emissions in the two geographical areas, the chemical conditions leading to the production of acid rain are remarkably similar.

In a related project, he calculated sulfur dioxide emissions (sulfur dioxide is produced primarily by the burning of fossil fuels, such as coal and oil, and is a precursor of the sulfuric acid that makes acid rain what it is) and found that although these emissions have declined since the early 1970's, due to the Clean Air Act and other efforts, they are still much higher than acceptable. (Results of this study were published in the prestigious international scientific journal *NATURE* in January 1987.)



GLYN CLOYD

As an IES postdoctoral associate, Dr. Hedin will continue studies of acid precipitation. He is still collaborating with the Swedish research group to learn more about similarities and differences in rainfall chemistry, and will look at how these patterns affect the biology and chemistry of streams and lakes. For this work he will use primarily the waters of the Hubbard Brook Experimental Forest in New Hampshire, the site of the long-term Hubbard Brook Ecosystem Study.

Promotion

DONALD C. BUSO was recently named manager of field research at Hubbard Brook. He has a bachelor of science degree in ecology from Cornell University, and has worked with Dr. Likens at the Hubbard Brook Ecosystem Study in New Hampshire since 1975, most recently as a research assistant III. His new responsibilities include supervising the weekly sampling of streamwater and precipitation in the Hubbard Brook Experimental Forest; organizing and interpreting data as they are collected; and troubleshooting scientific instruments.

Staff

Visitors to the Arboretum will meet two new IES staff members in the reception areas.



GLYN CLOYD

At the Plant Science Building, **SANDY CAHILL**, part-time receptionist, greets visitors and operates the switchboard three days a week.

At the Gifford House, **SU STUDLEY**, visitor services coordinator, welcomes and provides an orientation for Arboretum guests. Additional responsibilities include operating the Gift and Plant Shop.



GLYN CLOYD

Local Weather

Data collected at the IES Weather Station provide background information for ecological research at the Institute and serve as a standard against which long-term trends in weather and air quality may be compared.

July and August, 1988

Highest temperature: 37.2°C (99°F) on July 8

Lowest temperature: 5.0°C (41°F) on

August 22

Number of days high temperature at least 32°C (90°F) this year: 29

Daily average temperature: 23.3°C (74°F) (Normal*: 20.6°C (69°F))

Precipitation: 44.20 cm (17.40 in.) (Normal: 19.30 cm (7.60 in.))

Average rainfall pH**: 3.86

Total precipitation since January 1st: 80.87 cm (31.84 in.)

(Normal: 67.54 cm (26.59 in.))

Strongest wind gust: 39 km/hr (24 m.p.h.) from the Northwest on July 2

Prevailing wind: South-southeast (166°)

Average wind speed: 6km/hr (4 m.p.h.)

**"Normal" values are taken from data collected for a 30-year period at the Millbrook School.

**Degrees of acidity or alkalinity are indicated using a logarithmic pH scale. On the scale of 0-14, vinegar - an acid - has a pH of approximately 3, and "neutral" is 7.0. The pH of "normal" rain is 5.6 or higher.



JILL CADWALLADER

*5th Anniversary: After a meeting of all IES staff, at which Dr. Likens summarized the Institute's progress (see **Director's Note** on page 1), there was a surprise celebration. Dr. Likens cut the first piece of cake decorated for the occasion.*

Eco-Inquiry, from page 1

encouraged to adapt the program to their individual situations. An IES scientist will sponsor each class and "collaborate" with the student researchers. Teachers will also receive direct support through classroom visits by IES educators. At the end of the year, revisions will be made based on suggestions submitted by the participating teachers.

Thus, Eco-Inquiry is moving one step closer to fulfilling its potential as a practical, stimulating and rewarding experience for teachers and upper elementary school students. The long-term goal of the Institute of Ecosystem Studies is to have the revised curriculum published and eventually incorporated into school science classes throughout New York state and the U.S.

Fall/Winter Calendar

CONTINUING EDUCATION PROGRAM

The winter term will begin during the third week of January. Catalogues describing courses, workshops and excursions during the winter and spring terms will be mailed before the holidays.

SUNDAY ECOLOGY PROGRAMS

Free public programs are offered on the first and third Sunday of each month, except over holiday weekends. All programs are from one to two hours long, and begin at 2:00 p.m. at the Gifford House on Route 44A unless otherwise noted.

Tentative schedule (please call (914) 677-5358 to confirm the day's topic):

Dec. 4: An Acid Rain Update (Gene E. Likens) - Talk

Jan. 15: Slide presentation by Dr. Steward Pickett on flowers & pollination.

Talks are held indoors at the Gifford House. In case of inclement weather, call (914) 677-5358 after 1 p.m. to learn the status of the day's program.

ART EXHIBIT

"To Catch the Wind", drawings and paintings of birds by wildlife artist Karen L. Allaben-Confer, is open to the public at the Plant Science Building through mid-January. Hours: Weekdays, from 9 a.m. to 4 p.m. Admission is free. Notecards by the artist are for sale at the IES Gift Shop.

GREENHOUSE

The IES Greenhouse performs double duty: it is a year-round tropical-plant paradise as well as a site for controlled environmental research. The public is invited to explore both aspects during Arboretum hours. There is no admission

fee, but visitors should first stop at the Gifford House for a free permit.

ARBORETUM HOURS

October 1 - April 30: Monday through Saturday, 9 a.m. to 4 p.m.; Sunday 1 - 4 p.m. The Gift and Plant Shops are open Tuesday through Saturday 11 a.m. to 4 p.m. and Sunday 1 - 4 p.m.

Closed on public holidays. (Also closed during the deer hunting season -- Nov. 21 - Dec. 13, 1988 -- and when roads are snow covered.)

All visitors must obtain a free permit at the Gifford House for access to the Arboretum. Permits are available up to one hour before closing time.

MEMBERSHIP

Become a member of the Mary Flagler Cary Arboretum. Benefits include a special member's rate for IES courses and excursions, a 10% discount on purchases from the Gift Shop, six issues of the IES Newsletter each year, free subscription to *Garden* (the beautifully illustrated magazine for the enterprising and inquisitive gardener), and parking privileges and free admission to the Enid A. Haupt Conservatory at The New York Botanical Garden in the Bronx. Individual membership is \$25; family membership is \$35. For information on memberships, contact Janice Claiborne at (914) 677-5343.

A NOTE TO OUR MEMBERS

The IES membership list and that of the NYBG in the Bronx have recently been converted to new computer systems. If you feel that you are not receiving all of our materials or if there are errors in your address, please contact Janice Claiborne, Membership Secretary, at (914) 677-5343. We apologize for any discrepancies that may have occurred in this changeover.

For more information, call (914) 677-5358 weekdays from 8:30 - 4:30

INSTITUTE OF
ECOSYSTEM STUDIES
The New York Botanical Garden
Mary Flagler Cary Arboretum
Box AB, Millbrook, New York 12545



Newsletter

Volume 5, Number 5
September - October 1988

Nonprofit Org.
U.S. Postage
PAID
Millbrook, N.Y.
Permit No. 16



100% Recycled
Paper